1. Welds were found broken on the support bar that connects the outer air register front and back plate together. This was found on four different burners. Burner C4 (Photos #24 & 25)[1] had six of these bars broken and the back plate had subsequently warped at least 6 inches.

2. The register handle and quadrant were bolted together to prevent any adjustment so register doors could not be stroked to determine freedom of movement. The register doors were stroked a small amount (play in linkage) from the windbox. It was noted that three burners had register linkage that was locked tightly and would not move at all.

3. The register rear plate was warped (varied from 1/2" to 1") on twenty-six burners (Photos #22 & 23).

4. The register front plate was warped (Photos #18-21) on fourteen burners.

5. The burner register or the throat sleeve was misaligned with the bent tube opening of the waterwall (Photos #15-17) on eleven burners due to warpage.

6. The weld that connects the pull handle to the inner air zone disk was completely broken on one burner (Photo #28). Another inner air zone disk was cocked at an angle from vertical and was being held there by the pull handle.

7. The reinforcing bars that are welded to the outside of the inner air sleeve (Photos #26 & 27) showed signs of overheating on twenty burners. Large flakes of metal broke away from the burner with only fingertip contact. This was not caused by cutting or field alterations since it was not found on all burners. The maximum recommended working temperature of this material had undoubtedly been exceeded. Also, one burner had broken welds where the reinforcing bar attached to the inner air sleeve.

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[1]Throughout this report, references will be made to photograph numbers, for example, (Photo #1). All photographs referenced are attached in Appendix B, "INSPECTION PHOTOGRAPHS".

8. The support channel connecting the register front plate to the register support bracket was bent (Photo #7) and unable to slide freely on ten burners. This was caused by insufficient clearance between the retainer and register support bracket. The bending of the support channel distributes additional stresses to the register front plate which enhances the warpage of that plate.

9. The throat sleeve and the throat sleeve casing on all forty-eight burners needed repair or replacement. B & W Construction was making these repairs during the burner inspections. The rope seal packing was virtually non-existent. This was allowing large quantities of air to escape into the furnace without flowing through the burner. Also, approximately 90% of the welds connecting the throat sleeve casing to the furnace wall (Photos #8 - 10) were broken. The casing was free to move in any direction and this caused large gaps (1-2 inches) for air leakage into the furnace. A conservative 1" gap around the burner would amount to 6.9% of the throat area.

Throat area is $(\pi)58^2 / 4 = 2642$ sq in
Air gap is $(\pi)(58)(1) = 182.2$ sq in
Percent leakage is $182.2 / 2642 = 6.9$ %

10. A general observation noted on each burner level was that the middle burners had definitely experienced higher out-of-service temperatures (due to insufficient cooling air flow) than the outside burners. This is in contrast with in service burner operation where IGS personnel feel the problem is getting enough air flow to the outer burners.

3.2 Summary of Inspection Information

The general condition of the burners at this time is considered very poor. Numerous attempts to correct the problems have left the burners looking severely mistreated. All the register doors have been cut (Photos #1 & 2) to allow door movement due to register plates overheating and becoming severely warped. A triangular section has been removed along each door side that varies from one to two inches in width, and from the door tip to almost the door shaft in length.

The original clearance before modification was 5/16" from the register door edge to the register plate with a tolerance of plus 0" and minus 1/32". The register doors still have curved edges as a result of warpage before the door edges were trimmed. It appears that about 15% of the register door has been removed. Many register door shafts (Photo #3) are also bent and rotation appears difficult. The result of these modifications is a register with decreased ability to generate swirl, and a register that would have severe leakage in the closed position.

The outer air register assemblies have all been cut free from the inner air sleeve (Photo #4) so that these registers can move independently from the rest of the burner. The throat sleeve has also been cut free from the register front plate. Metal clips were installed in an attempt (Photos #5 & 6) to restrict the amount of movement between the throat sleeve and register front plate. The register is presently supported in only three locations. One is at the top of the inner sleeve, and the other two are supports from the register front plate (Photo #7) to the register support bracket. This support system promotes individual movement of the register plates which results in weld failures.

Burner component failures and the number of occurrences recorded during the Unit 1 Spring outage inspection are summarized below:

Description of Failure	Occurrences
Welds broken on register connecting bars	4
Register linkage immovable	3
Register rear plate warped	26
Register front plate warped	14
Burner misaligned with bent tube opening	11
Weld broken on pull handle to sliding disk	1
Sliding disk severely cocked	1

Inner air sleeve reinforcing bars overheated	20
Support channel bent and bound	10
Throat sleeve and throat sleeve casing warpage	48

3.3 Burner Inspection Conclusions

The burner inspection revealed that the burners have received a combination of high temperatures and stresses. The excessive temperatures have severely warped the stainless steel components and exfoliation of the carbon steel exists on 20 separate burners. The burners are also improperly supported which, along with the high temperature conditions, results in permanent warpage of the burners. In an effort to correct these problems, the burners have received field modifications that have created additional stresses.

4.0 BURNER EVALUATION

4.1 Existing Burner Design

The size of the 70 inch register greatly exceeds any other previous burner register sold by B&W. The diameter of this register was increased from the previous standard size while all plate thicknesses, material specifications, and manufacturing processes remained essentially the same. This has created two problems. The burner temperatures are higher than expected even using the "normal" amount of cooling air, which can be attributed to increased radiant heat transfer through the larger furnace wall throat opening. The other problem is that higher combined (thermal, residual, bending, etc.) stresses are greater. The combination of higher stress and higher temperatures have produced the higher than expected rate of deterioration.

4.2 Metal Temperature Limitations

The majority of the stainless steel material on this burner is AISI 304. Although the maximum operating temperature (with regard to oxidation resistance) of this particular stainless steel is several hundred degrees higher, the creep strength is greatly reduced at elevated temperatures. Creep strength is the ability to resist permanent strain that increases as a function of time and temperature under stress. Depending on the information source, the creep strength of AISI 304 stainless steel is reported as approximately 9.5 KSI at 1150°F and 3 KSI at 1350°F. Figure 3 illustrates the creep strength vs. temperature relationship for 304 stainless steel. For a long term installation such as this burner, the 304 stainless material should be limited to 1150°F.

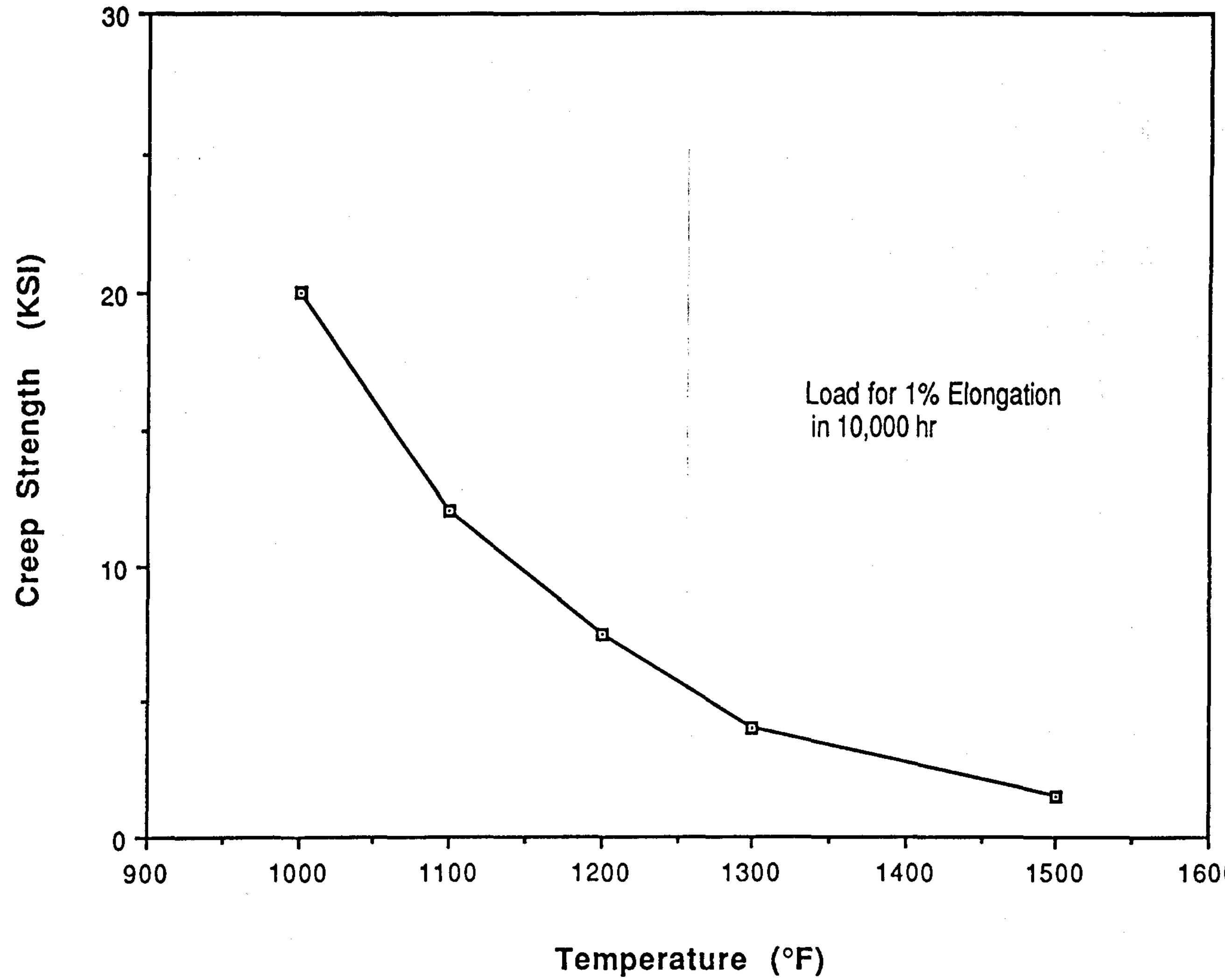
The carbide phase of carbon steel may be converted to graphite when subjected to prolonged temperatures of above 800°F. For a wear part such as the coal nozzle and non-pressure parts, the maximum temperature for carbon steel should be limited to 850°F. The thermocouple on the coal nozzle is located at the junction of the stainless and carbon steels. This thermocouple should be set to alarm at 850°F. The reinforcing bars that are welded on the outside of the inner air sleeve have definitely exceeded their allowable temperature. Large flakes of material can be picked off of the bars and the material that remains is porous and brittle.

4.3 Cooling Air Requirements and Monitoring

It was apparent from the inspection that temperature variations around the burner exist during boiler operation. A thermocouple on one side of the burner may not indicate excessive temperature, but, in fact, at a different radial position around the burner the recommended temperature is being exceeded. These thermal gradients produce high thermal stresses that cause severe warpage.

Correct distribution of the cooling air to each out-of-service burner is the optimum way to reduce these temperature variations. Because cooling air flow is limited due to other boiler operating constraints, it is very important to effectively use what is available. Individual windbox compartment secondary air flow measurement would be beneficial so the flow can be balanced to each burner level.

The burners registers and sliding disk are currently adjusted for on-line operation. When the burners are taken out-of-service no adjustments to burner registers are made. The windbox pressure for in service burners is approximately 1.0 inch of water, and out-of-service windbox pressure is -.7 inch of water. Under these conditions it is difficult to imagine that the cooling air is being



Creep Strength vs. Temp. for AISI 304 SST

Figure 3

distributed equally. The pressure drop across the burner is simply too small (without register adjustment) to assure equal air distribution.

It was observed during the burner inspection that the burners located in the center of the windbox have experienced much higher temperatures than the outside burners. This has occurred when the burners are out-of-service and was caused by insufficient cooling air to the center burners. This phenomenon is illustrated in Figure 4, a typical printout of burner thermocouple temperature indications from Unit 1. Row H is out-of-service and burner number 3 is experiencing higher temperatures than the outer burners - which is generally the case. Also note that the secondary air damper is at 30% and not the usual 10%. The coal nozzle temperature variance is 70 to 100°F and the register plate variance is 100-140°F. These differentials will increase as the cooling air quantity is reduced. Indications are that the coal nozzle is approximately 280°F cooler when the burner is in service and the register plate is 200°F cooler. The temperatures on the throat seal fluctuate 300°F or more due to the large gaps in the slip seal casing. The thermocouple is evidently located near a large gap when a temperature of 600-800°F is reported. The air leakage through the large gaps in the slip seal casing only compounds the limited air flow problem. The air bypasses the burner and thus provides little cooling to the burner components. The air gap on the slip seal casing must be maintained at a minimum.

Pitot tubes located in the burner air stream would be one method for balancing cooling air to each burner, but it would be a difficult application on this burner. Another method would be to perform burner air flow measurements with cool secondary air flow in order to balance the flow to each burner. This could be accomplished by inserting a telescoping pitot tube assembly down the coal nozzle. Actual measurement time is small, however, all the testing must be performed with the boiler out-of-service. A significant amount of time is required to prepare the coal elbow and to perform the testing. In an iterative fashion, a register setting would be determined for each burner for out-of-service operation.

A third approach would be to provide register drives on each burner so that operators could vary register position on out-of-service burners until acceptable

IGS UNIT #1

Unit Load 840 MW

	East		West
D	(2) 590.F 1014.F 972.F 877.F	(4) 569.F 1066.F 956.F 665.F	(6) 580.F 935.F 933.F 650.F
H	(1) 819.F 1110.F 985.F 1018.F	(3) 913.F 1223.F 1130.F 794.F	(5) 845.F 1083.F 1081.F 661.F
C	(2) 622.F 890.F 948.F 861.F	(4) 579.F 978.F 932.F 646.F	(6) 609.F 636.F 1052.F 953.F
G	(1) 562.F 969.F 916.F 966.F	(3) 551.F 1012.F 989.F 667.F	(5) 590.F 946.F 967.F 648.F

West		East	
(6) 581.F 994.F 835.F 715.F	(4) 474.F 834.F 1053.F 760.F	(2) 560.F 797.F 938.F 717.F	E
(5) 611.F 647.F 1027.F 964.F	(3) 546.F 1102.F 1132.F 879.F	(1) 589.F 1006.F 1064.F 654.F	A
(6) 602.F 956.F 1018.F 924.F	(4) 610.F 1052.F 1019.F 649.F	(2) 560.F 1042.F 1006.F 761.F	F
(5) 574.F 1006.F 960.F 1003.F	(3) 599.F 1007.F 1054.F 896.F	(1) 575.F 1064.F 1075.F 982.F	B

1. H Pulverizer O.O.S. with secondary air dampers at 30%.
2. All in service pulverizer feeders at 47 T.P.H.
3. All secondary air dampers on in service pulverizers at 65% position.

Notes: a. Burner number in parenthesis.

b. Description of burner temperature reading: (top to bottom)

Coal Pipe
Outer Register
Outer Register
Throat Seal

TYPICAL BURNER THERMOCOUPLE INDICATIONS
Figure 4

temperature indications are achieved. This would enable the out-of-service compartment cooling air flow to be minimized at all times.

4.4 Burner Line Fires

Several burners have experienced fires back in the coal nozzle that have destroyed the nozzle tips and diffusers. Coal particles are probably settling out in the coal pipe to cause these fires. The coal nozzle velocity is in line according to the Pulverizer-Burner Coordination Curves. The concern is whether or not these velocities are maintained throughout the coal pipe. If test connections are located correctly and tests prove that these velocities are correct to each burner, then the velocity should be increased in small amounts to determine if this will eliminate the fires.

4.5 Register Controllability

The registers and sliding disk should be adjustable under all conditions. The burner should adjust so that a turndown ratio that is established by the pulverizer operating range can be accomplished. The burner should also be capable of being closed completely so that a large enough pressure drop can be created to equally distribute the cooling air. Considering the amount of trimming that has taken place on the register doors, it is questionable whether or not enough pressure drop can be created to accomplish this. Other ways of closing the register openings such as shrouds could be utilized.

The physical appearance of the registers would indicate that adjustment while in service would be impossible for approximately 50% of the burners. The severity of the warped register plates and the bent door shafts create binding that prevents any adjustment. Register adjustment during the inspection was not allowed due to the fear that the register doors would not return to their original position. Only two sliding disks appeared to be impossible to operate. The remainder of the disks were free from any binding and appeared to be in good shape.

4.6 Estimated Burner Life

Considering the current burner condition and the amount of deterioration that has taken place in less than five years, the estimated remaining burner life is expected to be less than five years. It is expected that the majority of the burners will have major failures like burner C4 (Photos #24 & 25) if the burners continue to operate under the present conditions. It is estimated that $29,500 per outage will be required for labor and materials to rebuild the burners to maintain their existing poor condition. The burner failures will result primarily from register and throat deterioration.

5.0 B&W'S REPAIRS TO BURNERS

5.1 Recent Repairs

B&W field service and construction personnel were on site during the one week outage when the burners were inspected. They were replacing the slip seal casing on all 48 burners on Unit 1. These casings have been repaired or replaced on previous outages. Several (4-8) small gusset plates were being welded on the outside of the casing in an attempt to hold the casing in place. The previous casing was welded directly to the tube wall. The casing would expand from thermal expansion (1/2-5/8" on the diameter) but was limited until it broke the welds. During this time the free end of the casing would expand and the casing would resemble a 45° cone. The packing would fall out and large gaps (1-2") would appear. This new installation is at best a short term replacement, because the problem of thermal expansion is not being addressed properly. By restricting the movement, large stresses will result or the welds will break again.

The alloy section of the coal nozzle was oval on a few burners and was replaced. This was probably caused by burner line fires.

5.2 Previous Repair History

In the first few years of service, many repairs were necessary on the original burners. These repairs were required due to original manufacturing deficiencies and installation errors. Since then, failures have been the result of excessive temperatures and stresses. Numerous alterations have been made in an attempt to keep the burners in an operating condition. Below is a listing of the most significant alterations.

Unit	Date	Description of Repair
1	11-86	Register plates were warped and a reinforcing band was attached to the rear plate. Numerous welds were broken and repaired.
1	5-87	Welds joining the air sleeve to the rear plate had failed. These welds were all cut free to allow differential expansion. Reinforcing bars on air sleeve were overheated. Two middle burners on each level had more severe warping due to the air disk being throttled. Thermocouples were installed by IPSC to monitor burner temperatures.
1	11-87	New HD registers were installed on front and rear walls of burner level four. The 22" alloy tip on all 48 coal nozzles was replaced with a 33" section. Retaining lugs and clips replaced the previous weld attachments on the throat and inner air sleeves.
1	3-88	The register vanes were trimmed on all registers. Lighter shrouds were re-attached.
1	1-89	Heavy duty auxiliary outer register drive arm handles were removed as they were not providing enhanced outer register mobility.

2	11-87	The 22" alloy tip on all 48 nozzles was replaced with a 33" section. Retaining lugs and clips replaced the previous weld attachments on the throat and inner air sleeves. The register doors were trimmed on all burners.
2	4-88	Lighter shrouds were re-attached.
2	9-88	Slip joint modification was made on all register drive rods to allow thermal expansion to occur. The welds joining the inner air sleeve to the rear plate was cut free to allow for thermal expansion on the lower 36 burners.

6.0 ALTERNATIVES

This section itemizes four different alternatives for future burner operation. Estimated burner life and a cost summary is included for each section. New registers for all of the alternatives should be installed as a one piece design to avoid the problems that were experienced with HD registers and to return the burners to an undamaged (like-new) condition.

6.1 Continue Current Mode of Operation

If the out-of-service burners continue to operate at 1350°F the HD registers, throat sleeves and throat sleeve casings will need replacing every 5-7 years. Burner maintenance will also be required at each outage to repair broken welds and straighten warped burner components as seen on Photos #'s 24 & 25. It is estimated that labor and materials for each outage will be $29,500. This does not include normal burner maintenance. Normal burner maintenance would be minor items such as replacing the rope packing, adjusting register linkage, cleaning sprayer plates, and cleaning spin vane gears. The registers will remain adjustable for only a short period of time and balancing of cooling air to each burner will be difficult. Performance of the Unit will remain the same. Burner replacement would require approximately a four week outage depending on the size of the crew. The following cost summary is based on a quantity of 48 burners for one unit. It assumes that the work is performed in addition to other work at the site and during a scheduled outage.

Maintenance Schedule

Slip Seal Casing Materials	\$10,560
Slip Seal Casing Labor	4,600
Register Repair Materials	200
Register Repair Labor	6,400
Coal Nozzle Tip Materials	2,500
Coal Nozzle Tip Labor	640
Construction Overhead, Supervision, Fee	4,600
Total Each Outage	\$29,500

Cost Summary

Material Cost	\$312,000
OEM Markup (assumed 100 %)	312,000
Engineering	20,000
Freight	12,000
Installation Labor & Equipment	432,000
Construction Overhead, Supervision, Fee	138,240
Major Maintenance Work (\$29,500 x 2X per yr x 6 yrs)	354,000
Total (every 6 years)	\$1,580,240

In order to calculate present worth, material/labor and fuel costs were escalated by 5% using the following formula:

$$S = P(1+i)^n$$

Present worth was then calculated using the following formula:

$$\text{Present Worth} = S \frac{1}{(1+i)^n}$$

$$i = 8.6\%$$

The present worth for this alternative based on maintenance work of $29,500 every six months, or $59,000 per year and burner replacement every 6 years is $5,826,274.

6.2 Eight Pulverizer Operation

The burners that are in service currently operate with satisfactory temperatures. The registers average about 1000°F and the coal nozzle average is approximately 580°F. If the registers were in "like-new" condition, (this would require new HD registers, throat sleeves, and throat sleeve casings) and all 48 burners would be placed in service, the estimated burner life would be 20-30 years. Burner maintenance would be minimal since the high temperatures could be avoided. Overall boiler performance should increase slightly. Eight pulverizer operation would eliminate the need for cooling air to out-of-service burners reducing excess air requirements, thus lowering stack gas losses. Additionally, fineness would improve since feeder speeds would lower nine percent which should offset the auxiliary power requirements of the additional pulverizer. However, operating the pulverizers at less than full load could cause vibration. Increased pulverizer maintenance work would then have to be taken into consideration. This alternative has a major impact on regular on-line pulverizer overhauls which would force pulverizer work to be conducted only during maintenance outages.

The following cost summary is based on a quantity of 48 burners for one unit.

Cost Summary

Material Cost (does not include OEM markup)	$312,000
OEM Markup (assumed 100 %)	312,000
Engineering	20,000
Freight	12,000
Installation Labor and Equipment	432,000
Construction Overhead, Supervision, Fee	138,240
Total (20-30 year life)	$1,226,240

The present worth for this alternative based on burner life of 25 years is $1,754,153. However, normal recommended pulverizer maintenance (3,000 and 6,000 hour) schedules would have to be omitted. While the cost impact of reduced preventative maintenance is unknown, it would undoubtedly be significant over the operating lifetime of the plant. This is not recommended as a reasonable alternative for IGS.

6.3 Increase Cooling Air Requirements

The burners should be rebuilt to like new condition (this would require new HD registers, throat sleeves, and throat sleeve casings) along with the following modifications so they can operate for 20-30 years at 1150°F. The coal nozzle thermocouple should be limited to 850°F.

1. The outer register should have additional supports. Allowing the register assembly freedom to move independent of the inner air sleeve is desirable, but the register rear plate should also be supported off of the register support bracket as is the front plate. Round edges and adequate clearances should also be incorporated into the register support bracket retainer to assure that the register assembly can expand as needed.

2. The throat sleeve casings should be redesigned to allow for the large thermal expansion. This will eliminate the extreme warpage and weld breakage.

3. The coal nozzle alloy tip length should be increased to 48 inches.

Operating at reduced temperatures will minimize burner maintenance. Boiler performance will be affected, however, by the increased cooling air flow requirements. IPSC provided the following cost evaluation information that was used for the economic analysis.

Cost Evaluation Information

Unit Life (for each)	35 years
Capacity Rating (each unit)	800 MW net
Net Unit Heat Rate	9600 Btu/Kwhr
Capacity Factor	83 %
Equivalent Availability	89 %
Forced Outage Rate	2 %
Load Factor (gross)	95 %
Fuel Costs	1.45 $/MBtu
Boiler Efficiency	89.4 %
Change in out-of-service Burner Temp. versus change in Boiler Efficiency	100°F/ 1/2 %
Cost of Money	8.6 %
Operation and Maintenance Escalation	5.0 %
Fuel Escalation	5.0 %

The boiler efficiency would decrease by 1% when the out-of-service burners are maintained at 1150°F instead of 1350°F. The calculations for increased fuel costs in order to maintain current operation are shown below.

800 MW net x 83 % Capacity Factor = 664 MW
664 MW x 9600 Btu/Kwhr = 6,374.4 MBtu/hr
6,374.4 MBtu/hr x 1.45 $/MBtu = 9242 $/hr
Fuel Costs @ 89.4% Boiler Eff. = 80,967,628 $/yr

Heat to Steam = Eff_1 x Heat $Input_1$ = Eff_2 x Heat $Input_2$
(9600 Btu/Kwhr) x (89.4 %) = (X) x (88.4 %)
X = 9708.6 Btu/Kwhr
664 MW x 9708.6 Btu/Kwhr = 6,446.5 MBtu/hr
6,446.5 MBtu/hr x 1.45 $/MBtu = 9347 $/hr
Fuel Costs @ 88.4 % Boiler Eff. = 81,883,552 $/yr

Increased Fuel Costs per Boiler = 915,923 $/yr

The following cost summary is based on a quantity of 48 burners for one unit.

Cost Summary

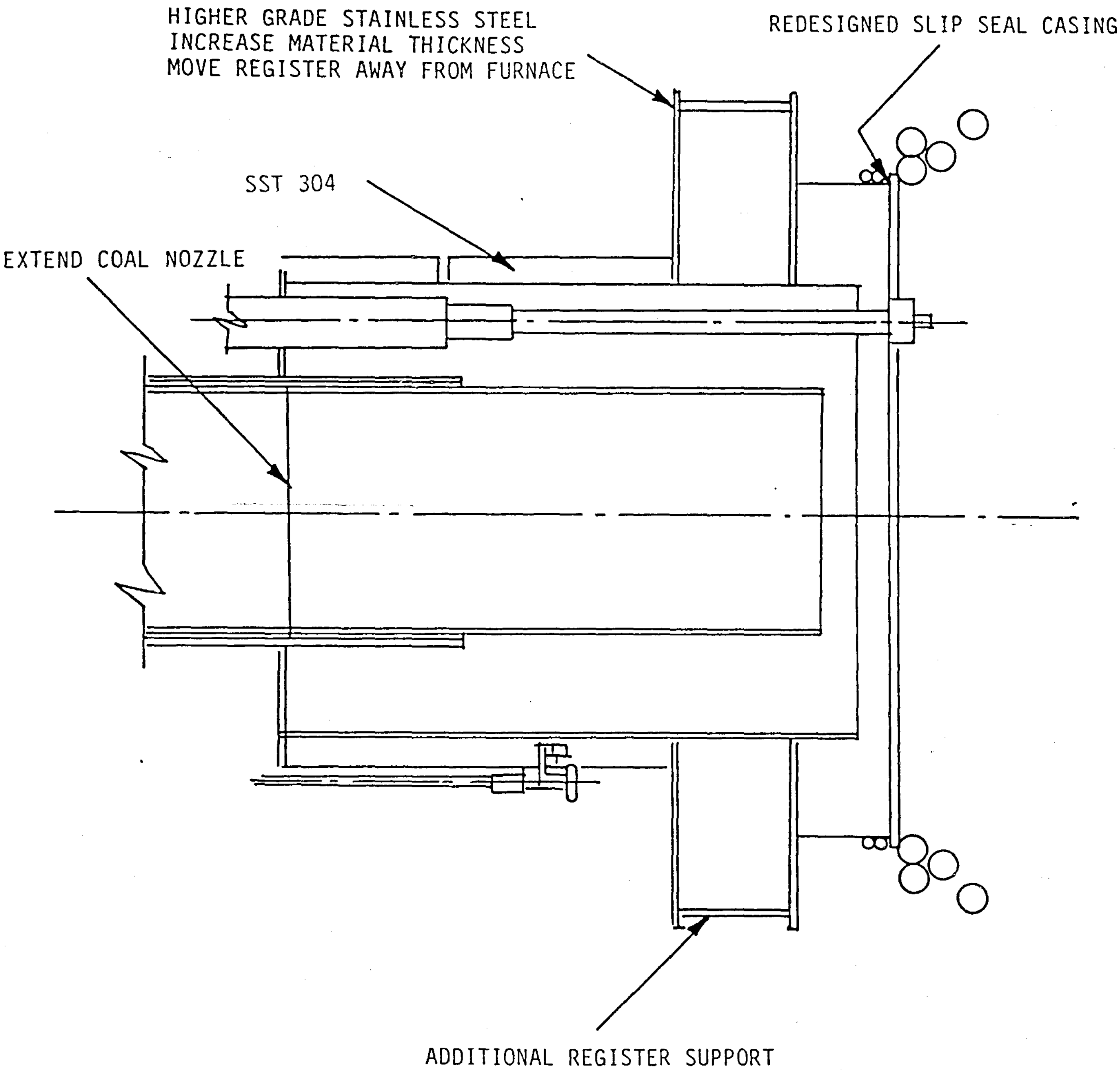
Material Cost (does not include OEM markup)	$408,000
OEM Markup (assumed 100 %)	408,000
Engineering	20,000
Freight	12,000
Installation Labor & Equipment	441,600
Construction Overhead, Supervision, Fee	141,312
Total (20-30 year life)	$1,430,912

The present worth for this alternative based on burner life of 25 years is $21,186,108.

6.4 Redesign Burner

Installing burners that have been redesigned to operate at 1350°F when they are out-of-service is the fourth alternative. The advantages of this alternative are that the boiler efficiency will not be affected and the estimated burner life would be 20-30 years. The burner would remain adjustable which would allow the cooling air flow to be balanced to each of the out-of-service burners. The new burner (see Figure 5) should incorporate the following design changes:

1. The stainless steel material and plate thickness should change on several of the burner components that have failed. This is evidenced by the current HD registers that have been installed in the upper row of burners and have already been permanently warped. A higher grade of stainless steel such as AISI 309 or 310 with a low carbon content would be better suited for high temperatures and welded constructions than a 304 material. This material would provide a higher creep strength and also alleviate long term effects of weld decay (Appendix C). Material thickness would probably also need to be increased on current 309 components to overcome the high stresses that are occurring.



REDESIGNED BURNER
Figure 5

2. The outer register should use the HD register linkage design. This will increase the ability of the register to remain adjustable. Placing the outer register farther back from the furnace should also be considered. This would reduce the amount of heat transfer by radiation and assist in lowering the temperatures of the register back plate and doors. The disadvantage could be the reduction of swirl that is imparted to the secondary air. Considering that the existing burners have good stability while operating with low pressure drop across the burner and severely trimmed register doors, high swirl is evidently not required with the current fuel.

3. The slip seal casing should be redesigned to allow for larger thermal expansions.

4. The reinforcing bars that are welded to the outside of the inner air sleeve should be SST 304 instead of carbon steel.

5. Extension of the alloy tip on the coal nozzle would be necessary because the temperature at the carbon steel junction should be limited to 850°F. The alloy tip should be 48 inches long.

6. Both outer register plates should be supported with register support brackets. Round edges and adequate clearance should be provided on the register support bracket retainer to assure that the register assembly can expand as needed.

The following cost summary is based on a quantity of 48 burners for one unit.

Cost Summary

Material Cost (does not include OEM markup)	$476,000
OEM Markup (assumed 100 %)	476,000
Engineering	40,000
Freight	12,000
Installation Labor and Equipment	411,600
Construction Overhead, Supervision, Fees	141,312
Total Cost (20-30 year life)	$1,586,912

The present worth for this alternative based on burner life of 25 years is $2,270,099.

7.0 RECOMMENDATIONS & CONCLUSIONS

The following table is a summary of the present worth for the four alternatives:

Current Mode of Operation	$5,826,274
Eight Pulverizer Operation*	$1,754,153
Increased Cooling Air	$21,186,108
Redesign Burner	$2,270,099

* Does not include maintenance considerations

7.1 Recommended Alternative

The best alternative to resolve the burner problems that are being experienced at IGS Units 1 & 2 is Alternative #4. Replace the register assemblies with the redesigned one-piece HD style and install new throat sleeve and throat sleeve casings with a new design that will operate at 1350°F. Boiler efficiency will not be affected and estimated burner life should be 20-30 years. The current condition of the existing burners warrant this change because they have a short life expectancy. The following schedule denotes the time required to get the burners installed after a purchase order release.

Burner Procurement & Installation Schedule

Purchase Order Release	
Engineering	12 weeks
Material Procurement	6 weeks
Fabrication	24 weeks
Shipping	2 weeks
Installation	4 weeks
	48 weeks

7.2 Interim Solution

It is recommended that cooling air flow be increased to limit the burner temperatures to 1150°F to reduce additional damage. This will reduce the chance of a safety risk and possible forced outage due to major burner failure.

It is also recommended that IGS run all eight pulverizers whenever they are available for service. This will minimize the period of time that burners must experience the high out-of-service temperature conditions.

7.3 Instrumentation & Controls

Air flow measurement to each windbox compartment for maintaining consistent air flows and register drives for balancing air flow to out-of-service burners would be beneficial in reducing the total amount of cooling air. However, retrofit of compartment air flow measurement instrumentation and register drives would require a multi-million dollar expenditure. In addition, a significant amount of maintenance is required to keep the equipment operating. Because of the other available alternatives, additional instrumentation and controls are not recommended at this time.